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Handbook
Operation and Service Instructions
with
Illustrated Parts Breakdown

RF WATTMETER, MODEL 670

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Lockheed Aircraft Service
17 APR 1963

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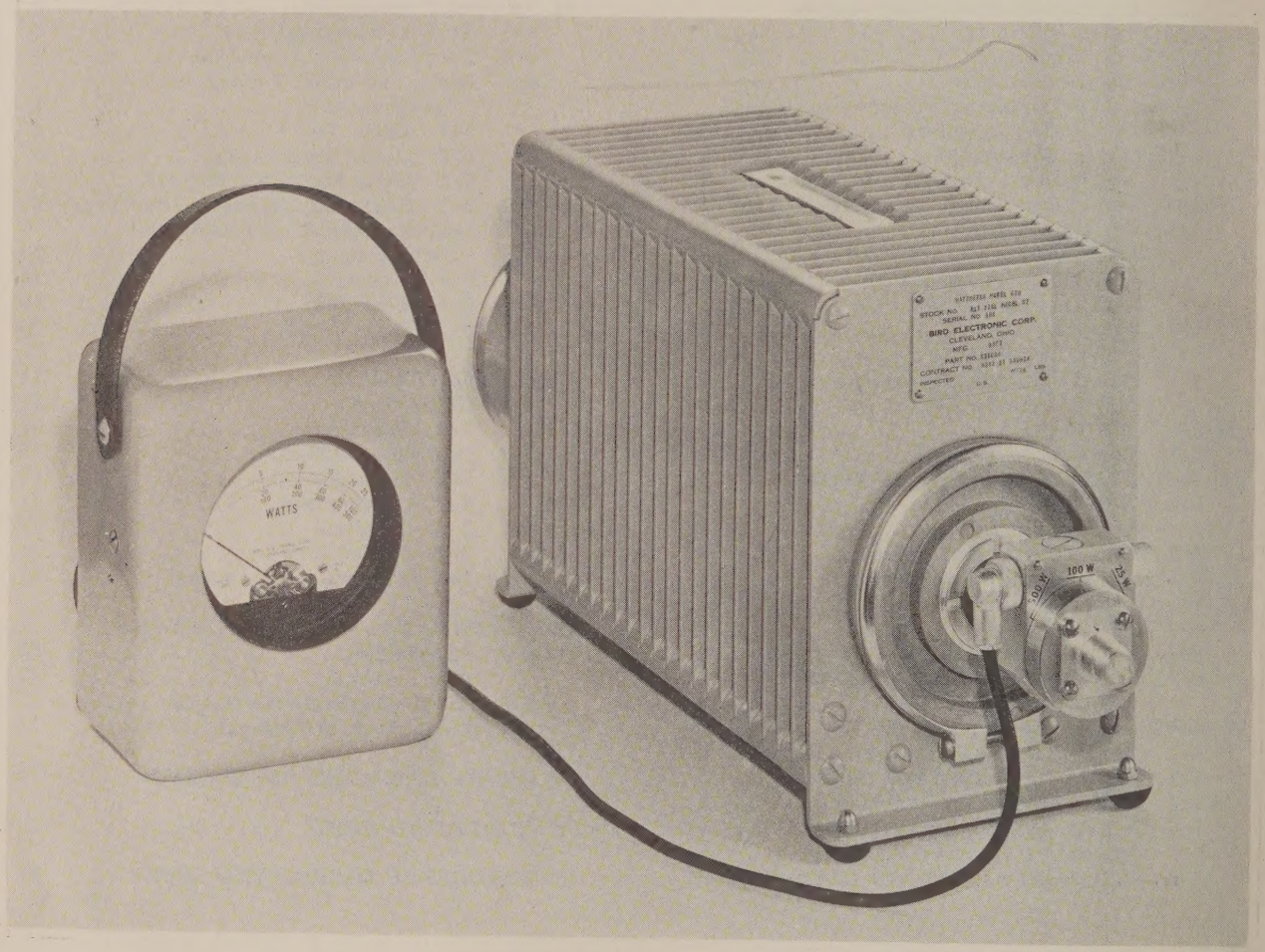


Figure 1-1. Photograph of Model 670 RF Wattmeter

SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION

1-2. GENERAL. This handbook contains instructions for the installation, operation, maintenance and repair of the Wattmeter Model 670 and includes an Illustrated Parts Breakdown to be used in conjunction with the service instructions to aid in the location, requisition and replacement of parts. The Model 670, ASO stock number R17BIEL-Model 67, is manufactured by the Bird Electronic Corporation of Cleveland, Ohio for general test equipment use.

1-3. DESCRIPTION

1-4. PURPOSE. The Model 670 RF Wattmeter is a portable absorption type radio frequency (RF) wattmeter used to measure RF power from any source, and to facilitate the tuning of the transmitters, within its rating. It functions entirely without radiating signals into space, i.e., with transmitter disconnected from its antenna and feeding into the wattmeter only. The Model 670 does not require any accessory equipment and operates without the use of an outside power source.

1-5. APPLICATION AND LIMITATIONS. This equipment is designed for use only with 50-ohm coaxial circuits, for which it serves as an almost reflectionless termination. It operates on continuous wave (CW), amplitude modulated (AM) and frequency modulated (FM or television type) signals, but is not intended for use with pulsed power signals similar to radar.

1-6. POWER MEASUREMENT. The maximum power input of the Model 670 in ordinary air is 500 watts. Measurement may be made up to 500 watts (on a direct reading scale) in the frequency range from 30 to 500 megacycles with accuracy of $\pm$ 5% of full scale value.

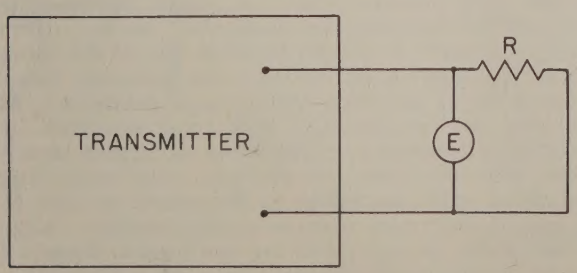


Figure 1-2. Basic Method of Power Measurement

1-7. DUMMY LOAD. The wattmeter may be used as a dummy antenna (load resistor only) for termination of 50-ohm coaxial lines on signals from 0 to 3000 megacycles per second within the same power limitation as paragraph 1-6.

1-8. TECHNICAL CHARACTERISTICS SUMMARY,

Load power	Up to 500 watts continuous in free circulating air.
Measurement range	0 to 500 watts in three ranges; 0-25, 0-100, 0-500.
Frequency range:	
For power measurement	30 to 500 mcs
As dummy antenna	0 to 3000 mcs
Circuit	Coaxial, 50 ohm impedance.
Modulation types	CW, AM, or FM. Not for use with pulsed power.
Accuracy	$\pm$ 5% of full scale.

1-9. EQUIPMENT. The equipment, figure 1-1, consists of two major units, the load resistor viewed on the right and the microammeter on the left. Both units are finished in a medium gray semi-gloss enamel, and fitted with rubber bumper feet. Convenient carrying handles are provided on the top side of each component. They are self-contained and individually carried. The load resistor unit includes the line termination, heat dissipator (coolant tank and radiator), and rf voltage detector. RF input is thru either LC or N-type interchangeable coaxial connector on the nose piece. The spare connector is attached to the back of the radiator. The microammeter is fed from the output of the rf voltage detector by a shielded cable, and reads measured power directly in RF watts on the selected level of the three range scale.

1-10. THEORY OF OPERATION.

1-11. PRINCIPLE OF POWER MEASUREMENT. This wattmeter measures the power dissipated in the resistor by the expression $W=E^2/R$. Here E is the voltage across the resistor R, thru which the rf

energy is flowing, as shown in figure 1-2. It is important in this measurement that the resistance of R be equal to the output impedance of the transmitter (50 ohms) and that the voltmeter be accurate at, or corrected for, the operating frequency. The construction of the load resistor produces a nearly constant characteristic impedance over the frequency range from 0 to 3000 mc, well beyond the 30 to 500 measuring band.

1-12. CIRCUIT DESCRIPTIONS

1-13. BASIC VOLTMETER CIRCUIT. Capacitors C302 and C305, with resistor R302, form an rf voltage divider across the load resistor R301 (figure 1-3). Capacitor C302 is of small value, to permit minimum effect on R301. The rectifying action of the crystal diode CR301 permits C305 to be charged, by alternate half-cycles, to the peak of the rf voltage applied across it by the voltage-divider action. Resistor R305 and microammeter M301 form a dc voltmeter circuit that measures the dc voltage developed across C305. Capacitor C301 is an rf bypass for meter M301. This arrangement makes up a shunt-diode voltmeter circuit. The circuit components, except the meter, are built onto the input of the rf load resistor.

1-14. THREE-RANGE VOLTMETER CIRCUIT. The wattmeter measures three separate power ranges 0-25, 0-100 and 0-500 watts respectively. These ranges are effected by rotating the voltmeter block, thus changing the capacitance of the series capacitor in the rf voltage divider circuit (C302 in figure 1-3). This avoids overloading the crystal diode on the higher-power ranges.

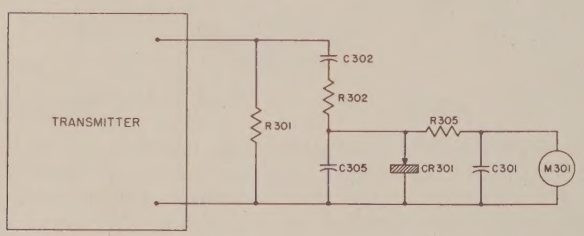


Figure 1-3. Simplified Schematic Diagram

1-15. RF LOAD RESISTOR

1-16. STRUCTURE. The structure of load resistor R301 (figure 1-4) coaxial. It has a characteristic impedance of 50 ohms from the input connector to a point about 2 inches behind the large mounting flange. The load resistance proper begins close to this point. The power dissipating portion of the resistor is the external surface of cylindrical, carbon film-on-ceramic resistor, which forms the center conductor of the coaxial termination system. At the far end of the resistor, the film is connected to a metal shell, which forms the return or outer conductor, of the coaxial structure.

1-17. RF LOAD IMPEDANCE. The vswr produced by the dummy load, when connected to a 50-ohm coaxial line, is shown in figure 1-5. This is an average curve, representing the results of measurements made on many dummy loads of this type. Although the curve is drawn for the power-measuring range of 30 to 500 mc, any individual dummy load will have a vswr that is less than 1.1 up to 3,000 mc. The input impedance at the connector is essentially resistive.

1-18. COOLING SYSTEM. To carry away heat, resistor R301 is immersed in Oil, Insulating, for Transformer, Switches, and Circuit Breakers (OT). The oil conducts the heat, generated by the rf energy, through openings in the coaxial metal shell (figure 1-4) to the inside wall of the cylinder. From there, the heat is conducted to the radiator cooling fins and, by convection, is carried away by the surrounding air.

a. The dummy load will handle power up to 500 watts continuously with air cooling only in surrounding temperatures up to 30°C (86°F).

b. Because the oil, which is a dielectric, forms part of the coaxial structure, a significant leakage will change the rf input impedance of the dummy load. If the oil loss is above 10 percent of the net volume, the measurements may be noticeably affected. The oil capacity is one gallon.

c. An expansion diaphragm is provided at the rear of the resistor housing (figure 1-4). As the temperature of the cooling oil rises, the oil expands; the diaphragm allows for this expansion. The diaphragm is removable and can be replaced if it leaks.

1-19. VOLTMETER DETAILS

1-20. CRYSTAL DIODE. The 1N79 crystal diode CR301 is inserted into a holder on the side of the voltmeter block and covered by a knurled screw cap. It maintains a dc voltage across the button-mica shunt capacitor C305 that is located close to the tip of the crystal connector (figure 1-4). Surrounding this connector is a small cylinder of ferrite that serves as an rf choke against excessive energy at high frequencies. The components are arranged in the voltmeter block for effective rf bypassing, with a minimum of residual inductance.

1-21. VOLTMETER ADJUSTMENT. The capacitors shown in figure 6-4 in section VI as C302, C303, and C304 are actually three electrode stubs (one for each meter range) mounted on the center conductor of the load resistor unit. A single electrode is mounted on the movable voltmeter block. This single electrode is placed opposite one of the three respective fixed electrodes when the voltmeter block is set at one of the three power-range positions. At the time of manufacture, each fixed electrode is specifically adjusted to calibrate its particular power value with the assigned crystal. Individual calibration of each wattmeter is necessary because of the lack of uniformity between crystal diodes. After the wattmeter is calibrated for one crystal diode, a second crystal diode (supplied as a spare) is selected to match the characteristics of the first. The voltmeter block is sealed after calibration, and can-

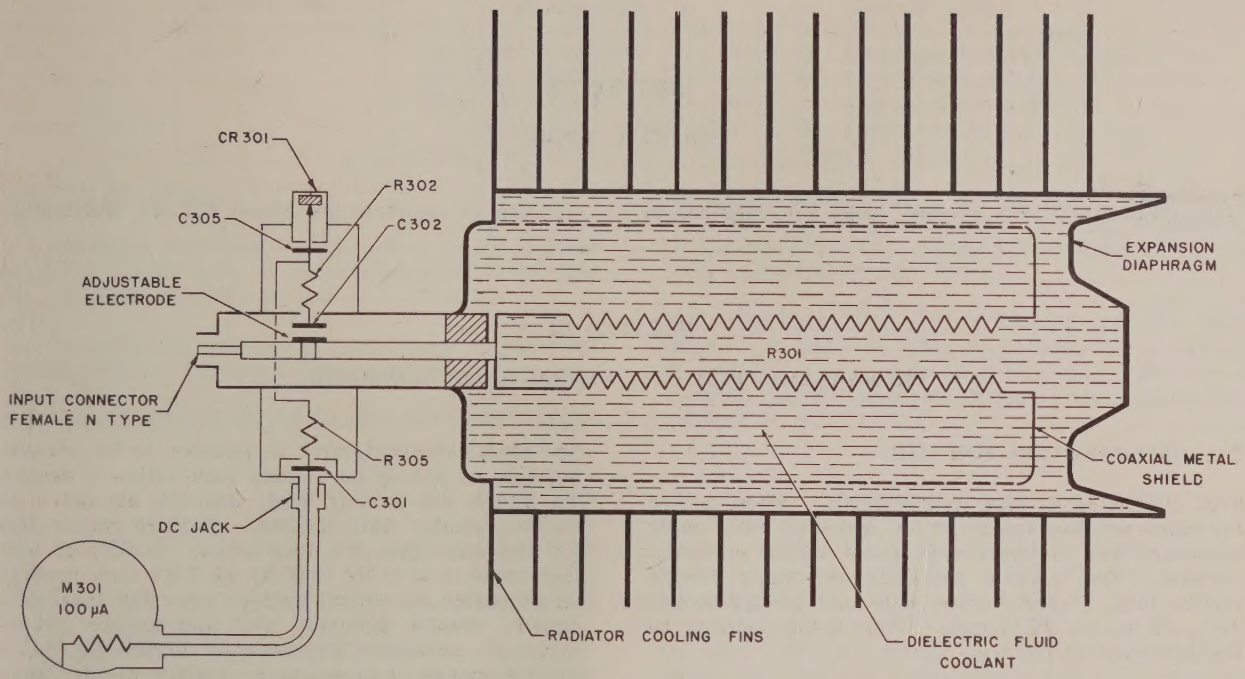


Figure 1-4. Cutaway Diagram of Wattmeter

not be adjusted by field maintenance procedures. If a 1N79 diode other than those supplied with the wattmeter is used, an error up to ± 20 percent of full scale power reading may be experienced.

1-22. DC OUTPUT. The output of crystal rectifier CR301 is fed to the dc meter circuit through calibrating resistor R305. Bypass capacitor C301 is a button-mica type, mounted inside the dc connector jack. The voltmeter block, the dc cable, and all other components of the meter circuit are protected by grounded shielding when the dummy load is grounded. This shielding and bypass capacitor C301 keep stray rf fields from affecting power indications on meter.

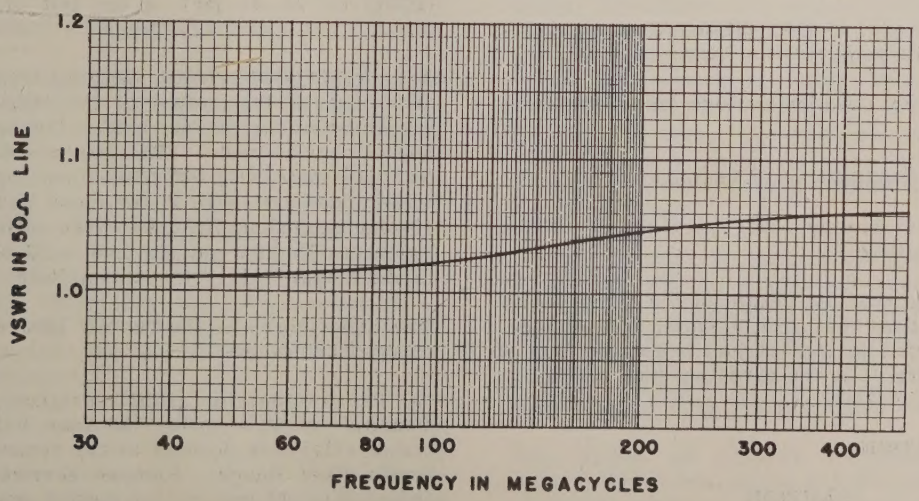


Figure 1-5. Vswr Curve

SECTION II

SPECIAL TOOLS

2-1. GENERAL. No special tools are required to operate or maintain the Model 670 RF Wattmeter.

SECTION III

PREPARATION FOR USE, STORAGE, OR SHIPMENT

3-1. PREPARATION FOR USE

3-2. UNPACKING THE EQUIPMENT. When packed for shipment, the wattmeter is protected with ample desiccant and moisture-vaporproof sealed in double cartons. The packed container measures 10-3/4 inches high, 7-5/8 inches wide and 25-1/2 inches deep and weighs 34 pounds. Unpack the contents by the following procedure.

a. Open the outer carton by removing the sealing strips.

b. Remove the inner carton that is wrapped in the moisture-vaporproof barrier. Carefully strip off the barrier.

c. Open the inner carton and remove the contents.

d. Remove the corrugated pads and the sleeve from the dummy load. Remove the bags of desiccant.

e. Open the small carton and remove the meter.

3-3. CHECKING AND INSPECTION. Check and adjust equipment (if required) as follows:

a. Inspect for any possible damage incurred during shipment.

b. Check for completeness of equipment.

c. Examine the dummy load, particularly at the ends, for oil leakage.

d. Check to see that the needle of the meter rests on zero. If it does not, with a small screwdriver, turn the screw that is located just below the face of the meter. Turn it in the direction that will make the needle rest on zero.

3-4. INSTALLATION

CAUTION

The load resistor (dummy load) must always be operated only in a horizontal position.

The Model 670 equipment is intended to be portable, but may be set up as a fixed installation if desired. To attach the dummy load, unscrew all acorn nuts on the radiator base flanges. Remove rubber bumper feet and expose the four holes. Drill four 9/32-inch holes in a 5-1/8 inch by 12-7/32 inch rectangle on a suitable horizontal surface near the transmitter output. Fasten securely with appropriate 1/4-inch bolts or screws. The location should provide at least 6 inches of open space at sides and top (more on top if available) in free air of normal temperature.

NOTE

Free circulation of air around the dummy load is important. Keep the unit in the clear as much as possible; do not use it near heated surfaces.

If possible, lay the meter face up on a convenient shelf or table. Rubber bumpers are provided on the back of the meter to resist shock or slipping. Uncoil the cable in the meter box and attach the plug (P301) to the dc jack on the left of the voltmeter block.

3-5. RF CONNECTIONS. With the transmitter turned off, connect the output of the transmitter to the connector on the dummy load. Use no more than 5 feet of coaxial cable. The coaxial-cable connectors that will mate with the connectors supplied with the dummy load are listed in the chart below. Use only 50-ohm cables and fittings. Even with a transmitter having a 75-ohm output, use a 50-ohm cable back to the output jack of the transmitter.

The connectors on the dummy load may be readily changed as follows:

a. The N-connector (J302), originally installed, is detached by unscrewing the four 8-32 round head screws that are located at the corners of the connector base flange. Remove screws and pull connector straight out; do not bend it any direction.

b. Unfasten the LC-connector (J301) by removing the two 8-32 machine screws retaining its flange to

Connector on dummy load	Mating plug	Coaxial cable
N	Rf Plug UG-18C/U Rf Plug UG-21D/U Plug UG-204B/U Connector Plug UG-941A/U	Rf Cable RG-5, 6, 21/U Rf Cable RG-8, 9, 10/U Rf Cable RG-14, 74/U Rf Cable RG-10, 12/U
LC	Plug UG-154/U	RG-17, 18/U

back fin of radiator.

c. Carefully introduce contact pin of LC-connector into the center hole of nosepiece; push it straight in. Replace the four screws.

d. Store spare connector/or connectors on the back of the radiator for convenience and safety.

3-6. EQUIPMENT REQUIRED BUT NOT SUPPLIED. No other power source or accessory equipment is required. No other components need to be attached. No outside connection is required except the rf power input described in par. 3-5.

3-7. PREPARATION FOR STORAGE AND/OR SHIPMENT. Repack in original cartons and materials, if available, about the same as first received. Be sure to include ample desiccant; reverse procedure outlined in par. 3-2.

SECTION IV

OPERATING INSTRUCTIONS

4-1. CONTROLS AND INSTRUMENTS. The wattmeter has only one control, the voltmeter block (located behind the connector on the dummy load), used to select the desired scale on the meter. The number that is lined up with the mark above the connector shows the rf power input required for full scale deflection of the meter.

CAUTION

Do not try to turn the voltmeter block beyond the outer stops.

The meter has three full scale ranges for power measurement, viz: 25, 100, and 500 watts.

4-2. MEASURING TRANSMITTER POWER.

a. With the transmitter turned off, connect the transmitter output to the dummy load (par. 3-5). Set the voltmeter block to select the desired range.

CAUTION

If the approximate power output of the transmitter is not known, set the voltmeter block to the 500W position. Turn on the transmitter and determine the required power range. If the voltmeter block is set below the input power, the crystal diode and meter may be damaged.

b. Allow the transmitter a few minutes to warm-up and stabilize itself. The meter indicates the power that is applied at the input connector of the dummy antenna. Losses introduced by the cable between the transmitter and the dummy load, if significant, must be added to the power indicated by the meter.

c. The dummy antenna is a 50-ohm termination. When the desired output power has been obtained, note the readings of the meters that are associated with the output stage of the transmitter. These bear a relationship to the power output; they are useful in relating a transmitter's output to its antenna, to the output to the wattmeter.

WARNING

Turn of the transmitter before changing rf connections to the dummy load. Failure to do this is dangerous.

d. When the transmitter is reconnected to the antenna, the difference in antenna loading may increase the voltage standing wave ratio (vswr) in the transmission line. Retune the transmitter for the desired output, if necessary, using the instructions in the manual for the transmitter. An antenna line monitor (provided in some transmitters) may show wide differences when peaked with the wattmeter and when peaked with the antenna. Refer to the manual for the transmitter.

e. The power values into the antenna and into the wattmeter will be essentially equal if the vswr on the antenna transmission line is less than 1.05. This condition may be recognized if, after the transmitter is readjusted, the line monitor, or the meters associated with the output stage, indicate the same values noted when the wattmeter was used.

4-3. USING AS DUMMY ANTENNA. When used without the crystal diode and the meter, the dummy load will serve as a 50-ohm termination for transmitters at all frequencies from zero to 3,000 mc. The vswr over this extended range is low enough

although figure 1-5 shows values only for the power-measuring range.

a. To remove the crystal, unscrew the crystal cap on the right of the voltmeter block. Insert the edge of a knife under the flange of the crystal diode and pry it away from the flat springs that hold the diode. Remove the diode with the fingers. Do not remove when rf power is on, it will damage crystal.

b. Disconnect the meter by unscrewing the meter cable connector at the dc jack on voltmeter block opposite the crystal socket.

c. Operate the dummy load within the same power limits as when measuring power.

d. Paragraph 4-2c, d, and e also apply to this function.

4-4. REGULAR OPERATING PRECAUTIONS.

a. Carefully check the condition of the cable and connectors used to connect the transmitter and the dummy load.

b. Assemble connectors properly; misalignment may cause broken center pins. In addition, proper assembly is important to provide correct impedance match.

c. Use as few connectors and adapters as possible. Use constant-impedance 50-ohm connectors and adapters.

d. When other than 50-ohm connectors or adapters must be used, keep them at the transmitter output connector, so that the connecting cable will be free from standing waves. The vswr will be as low as possible.

4-5. OPERATOR'S TESTS FOR ACCURACY.

a. Operating checks should consist mainly in comparing the wattmeter with another of the same type. This is a practical check for both. Allow enough time for the transmitter to stabilize for each check. The indications on the wattmeters should be within 10 percent of each other below 5, 20, and 100 watts respectively, and within 5 percent for higher indications. Comparisons can be made most accurately by adjusting the tuning and coupling of the final tank of the transmitter for the same plate current and plate voltage values for each wattmeter.

b. Check the spare crystal against the operating crystal. The spare crystal is stored in a holder inside the bottom of the meter box. From the rear, unscrew the knurled cap and remove spare crystal for use. When a steady power reading is obtained for a transmitter using one crystal, turn off the transmitter and install the other crystal. Refer to paragraph 4-3a for instructions on removing the crystal. Turn on the transmitter, checking to see that the transmitter meter readings are the same. The wattmeter indication should be within 3 percent of full scale of the previous indication.

c. The three power ranges of the wattmeter may be cross checked at 25 watts and 100 watts respectively. Remember that in checking the 100-watt power level on the 500-watt scale, the $\pm$ 5 percent full scale tolerance allows a variation of $\pm$ 25 watts, against a variation of only 5 watts on the 100-watt scale. In the same manner, at 25 watts input, the $\pm$ 5-watt tolerance on the 100-watt scale is matched against the $\pm$ 1-1/4 watts on the 25-watt scale.

4-6. WATTMETERS VERSUS ANTENNAS AS LOADS. The wattmeter may load the transmitter differently from the antenna. This may be normal for broadband antennas because of vswr variation at different frequencies. Because the purpose of the transmitter is to drive the antenna, a slight retuning of the transmitter may be necessary after it is reconnected to the antenna.

SECTION V

PERIODIC INSPECTION, MAINTENANCE, AND LUBRICATION

5-1. INSPECTION. The ruggedness and relative simplicity of the equipment should make periodic inspection necessary only at about six months intervals. Checking procedure should include these items:

a. Oil leakage. Watch for oil leaking around the radiator tank, particularly at the front and back around the bottom side of the clamping bands 0301 and 0302. See par. 1-18b and par. 6-10 if leakage is observed. Check tightness of band screws.

b. Check tightness of dc plug P301, screws on rf connector J302 and spare connector J301. Check assembly screws on side faces of meter box and the spare crystal cover H303.

c. Check tightness of bumper feet H302 on meter box A302 and on radiator A303.

d. Inspect equipment for frayed, strained or deteriorated cords and cables.

e. Inspect contact pins in connectors for possible damage.

f. Check power readings of the spare crystal against the regularly operated crystal diode.

g. Inspect seating of crystal CR301 (push to bottom) and replace crystal cap H301 securely.

h. Check rotation of voltmeter block. Each index position should have a positive stop and rotation should not go past the end points.

i. Inspect meter M301. Clean glass face if necessary, check zero position of pointer and freedom of movement, paragraph 3-3d.

j. Inspect for completeness and general condition of equipment.

5-2. PREVENTIVE MAINTENANCE

5-3. GENERAL. This wattmeter requires only simple maintenance. The general construction is strong and durable. The meter should not be dropped or handled roughly. The crystal diodes are sensitive, handle them with care. Crystals are matched and selected for each equipment, do not mix with those of other wattmeters. If possible, try to keep dc plugs and rf plugs in place when equipment is not in use. It preserves and prevents dirt accumulation on contact portions of the connectors.

5-4. CARE AND CLEANING. Wipe dirt and dust off regularly. Pay special attention to all portions of voltmeter block, the clamping bands, and all the connectors. Clean dirty connectors carefully with Dry Cleaning Solvent 140-F (carbon tetrachloride) on a cotton swab stick. Remove all grime and dust from contact and insulator surfaces.

CAUTION

Ventilate working area. Be careful - do not breathe fumes of cleaning fluid.

If any portions of the radiator are corroded or rusted, clean the area carefully with a fine lint sandpaper and touch up with gray enamel.

5-5. LUBRICATION. This equipment does not require lubrication

SECTION VI

TROUBLE SHOOTING

6-1. TROUBLE SHOOTING CHART

Trouble	Probable Cause	Remedy
1. No Meter Indication	1a. No Rf Signal	1a. Check that transmitter is turned ON. If ON, check instructions for proper setup and operations of the transmitter. If other remedies below check OK, test transmitter.
	b. No Power Input	b. Check Rf Power Cable and connections to wattmeter. Do not loosen any connections while rf power is on, dangerous and damaging voltages will be exposed.
	c. Crystal diode	c. Check seating (contact) of crystal diode CR301, or try spare crystal CR302 to check for defective diode.
	d. Voltmeter defective	d. Replace load-resistor E301 Test unit per par. 6-9 & 6-11.
	e. DC meter cord W301 defective.	e. Tighten connection of plug P301 on dc jack. Test cord for short or open circuit. Repair if necessary per par. 6-6.
	g. Defective Microammeter M301.	g. Test for stuck or misplaced pointer. Check meter. Replace if necessary. See par. 6-4 and 6-5.
2. Irregular or Improbable Indications	a. Faulty Transmitter	a. Check Transmitter
	b. Loose connections	b. Check Rf connectors.
	c. Voltmeter not resting on an index position.	c. Check voltmeter indexing.
	d. Faulty crystal diode.	d. Try spare diode CR302

Note: Always be sure that the transmitter is operating properly.

6-2. TEST EQUIPMENT REQUIRED. Test equipment required for troubleshooting the wattmeter are listed below. A common name for each is listed at the right.

Nomenclature	Common name
Meter Test Set TS-682/GSM-1	Meter test set
Multimeter TS-352/U	Multimeter
Resistance Bridge ZM-4B/U	Resistance bridge
Standing Wave Indicator IM-89/UR	Standing wave indicator

6-3. METER AND CABLE TESTING AND REPLACEMENT.

6-4. METER TEST. Microammeter M301 is a sealed instrument, shockmounted in a portable housing. Because the sensitive meter is easily damaged, testing should be done only by personnel familiar with the instruments and circuits required.

a. Test the meter as a microammeter, using the meter test set. Fullscale current on the meter should be 100 microamperes $\pm$ 2 percent. Test the meter cable with the meter.

b. Inaccurate or no indications on the meter may be caused by a faulty meter cable. Unsolder one lead of the cable from the back of the meter and use the multimeter to check the continuity of both conductors. Also check for short circuit between the two conductors. Make the same tests on the cable between the dummy load and the transmitter. Do not use an old or worn cable unless it is tested in this manner.

6-5. METER REPLACEMENT. To replace the meter in the case, refer to figure 6-3 and proceed as follows:

a. Place the meter case face down on a smooth, clean surface.

b. Using the thumb and the fingers of one hand, press down evenly on the retainer ring A301 to compress the sponge-rubber strips 0 307 and 0 308.

c. Unscrew the two oval-head machine screws on the sides of the case. One of these screws can be seen in figure 9-2, as index part 9-2-8.

d. Remove the meter with the retaining ring A301 and the sponge-rubber strip 0 308.

e. Strip the vinyl lacing and the tubing from the terminal lugs on the back of the meter, and unsolder the leads of the meter cable. Carefully note the polarity of the leads.

f. Replace the tubing on the center conductor and solder the cable onto the new meter. Remove rosin flux from the soldered joints with cleaning compound.

CAUTION

Use the soldering iron sparingly.

g. Reverse the procedure in (b) through (d) above to install the new meter in the case.

6-6. CABLE PLUG REPLACEMENT. To replace plug P301 on the meter cable, refer to figure 6-1 and 6-2 and proceed as follows:

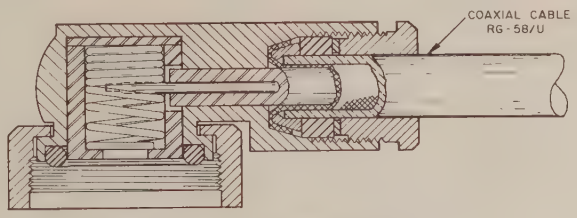


Figure 6-1. Connector Plug P301

a. To remove cable from the plug, unscrew the bushing and pull out the cable.

b. Slip the bushing, the washer, and the grommet over the end of the cable.

c. Remove the outer insulation from the cable to a point 9/16 inch from the end.

d. Comb out the shielding into straight wires.

e. Slip the collar over shielding.

f. Fold the shielding back over the collar and trim, as shown in figure 6-2.

g. Remove the inner insulation 3/16 inch from the end of the inner conductor.

h. Sharpen the end of the center conductor to a chisel edge.

i. Push the assembly into the remainder of the plug, aligning the edge of the inner conductor with the turns of the coil spring.

j. Screw down the bushing to a snug fit.

6-7. REPLACING EXPANSION DIAPHRAGM. To replace diaphragm 0 304, refer to figure 6-3 and proceed as follows:

a. Stand the dummy load upright, with the diaphragm end up.

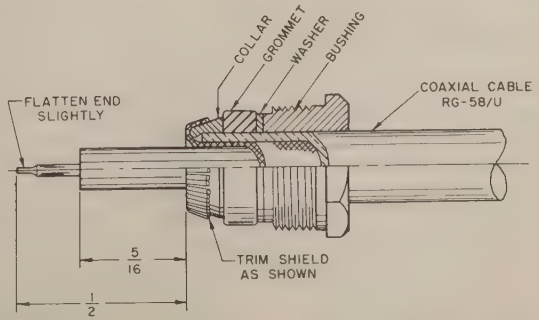


Figure 6-2. Cable Service for Connector Plug

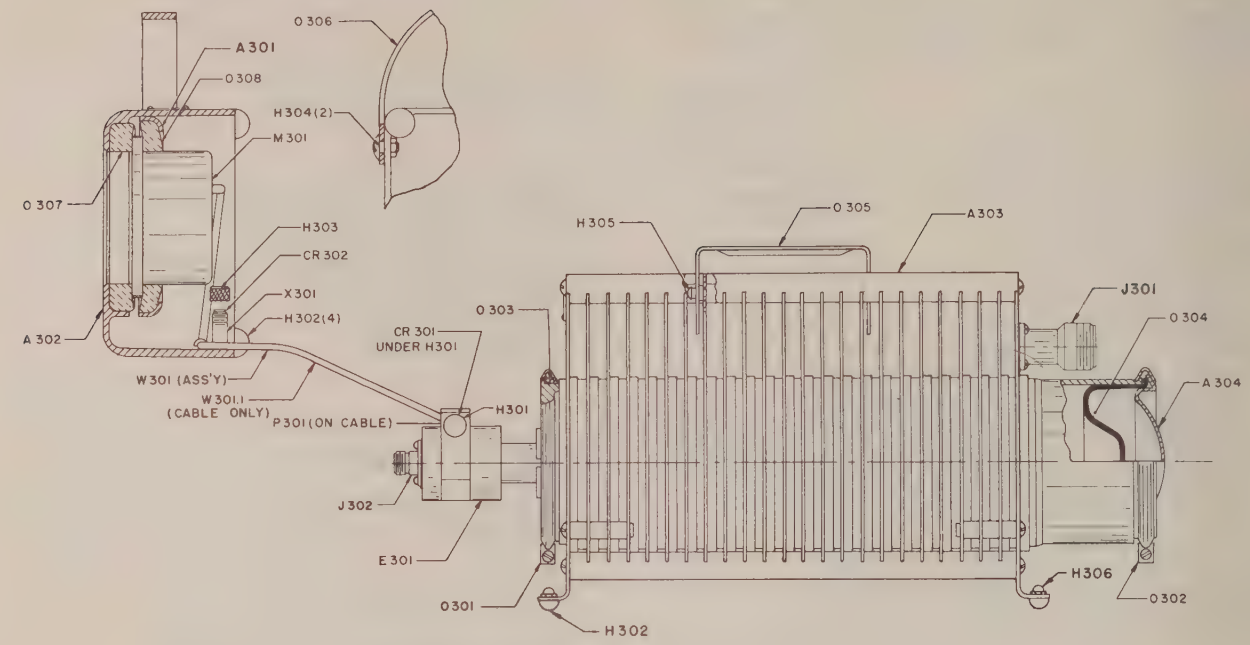


Figure 6-3. Maintenance Parts Designation

b. Loosen the screw in V-band clamp 0 302 until the clamp is released (the shank of the screw is disengaged from the threaded block). This releases V-band clamp 0 302 and cover A304. Remove the cover.

c. Lift the diaphragm 0 304 from the tank.

d. Examine the oil in the tank. If there is any evidence of contamination, discard the oil, and refill the tank to within 1 inch of the top with oil (OT).

e. Before reassembling the parts, be sure all mating surfaces are clean and in perfect condition. Keep the rear face of the tank cylinder free from marks and scratches.

f. Insert the replacement diaphragm.

g. Assemble the clamping parts by reversing the procedures in b. above. Tighten the clamp screw to a snug fit. It is not necessary to use excessive pressure to prevent leakage.

6-8. LOAD RESISTOR UNIT TESTING AND REPLACEMENT.

6-9. TESTING. To test the load resistor E301, measure its dc resistance with the resistance bridge. Use low resistance leads, preferably a short length of Radio Frequency Cable RG-8/U connected to a Radio Frequency Plug UG-21/U. This will mate with the N connector on the dummy load. The resistance should be 50 ohms $\pm$ 1.5 ohms. If the resistor is faulty, replace the entire unit.

6-10. REPLACEMENT. When replacing the load resistor, place the dummy load in a frame or a box. so that it will stand vertically with the connector end up. Refer to figure 6-3 and proceed as follows:

a. Loosen the screw on V-clamp 0 301 until the V-clamp is loose from the locking flange of the radiator cylinder.

b. Lift out the entire load resistor unit from the radiator tank. Allow enough time for the oil to drain back into the tank before moving it from above the cylinder.

c. Inspect sealing ring 0 303. Made from synthetic rubber, it is the seal for the tank opening. Do not use it again unless it is in perfect condition or in a case of emergency. Whenever possible, replace this part with a new one when replacing the load resistor unit.

d. Inspect the oil. Replace it, if necessary (par. 6-7d). When filling the tank from the connector end, measure the amount of oil required. Use one gallon (approx. 128 fluid ounces). If no method of measurement is available, fill the tank from the diaphragm end (par. 6-7b, c and d) after the load resistor unit is replaced.

e. After replacing the load resistor unit, make a vswr test (6-11 below) before putting the dummy load into operation.

6-11. FINAL TESTS. If the tests given in paragraphs 6-1 and 6-4 and in 6-9 above, do not produce results, the vswr of the dummy load may be too high or the voltmeter block may be faulty.

a. Check the vswr of the dummy load with the stand-

ing wave indicator. (A slotted line, if available, may be used). If the ratios are in excess of those shown in figure 1-5, replace the entire load resistor unit (par. 6-10 above).

b. If all of the foregoing tests do not disclose a fault, the trouble is in the voltmeter block. . Do not try to repair or replace it. The parts that retain it are permanently installed; they will be injured if they are tampered with. Replace the entire load resistor unit (par. 6-10 above.)

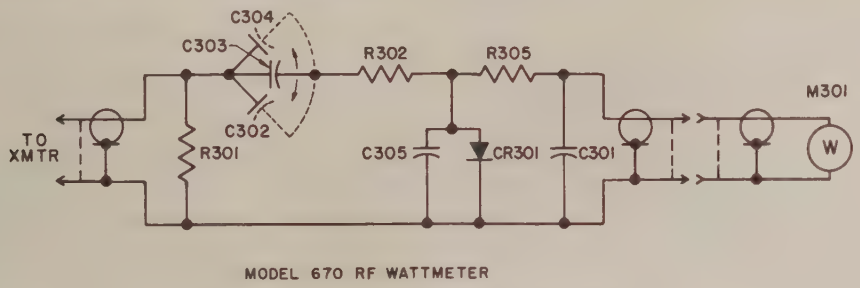


Figure 6-4. Overall Schematic Diagram

SECTION VII

CALIBRATION

7-1. CALIBRATION.

7-2. GENERAL. The calibration of the Model 670 Wattmeter cannot be directly adjusted by field maintenance activities. A unit that fails to check within stated tolerance will have to be replaced entirely or in certain components. With units failing to check calibration, use the Troubleshooting Chart in paragraph 6-1 to help ascertain source of trouble. Test and replace faulty items according to the procedures described in the remainder of Section VI.

7-3. CALIBRATION CHECKS

7-4. METHODS. Three apparent methods, by comparison, insertion wattmeter, or slotted line, may be used to check the calibration of these wattmeters, as described in paragraph 7-5, 7-6 and 7-7 below. The latter two methods are preferred.

7-5. COMPARISON. Refer to paragraph 4-5 and follow procedures described therein. Power measurement differences of about 10% (on the same transmitter) may be encountered between two satisfactory Model 670 Wattmeters even though the accuracy of inherent power measurement of each unit is well within ± 5%. The difficulty is that the actual power flowing to different Termaline Wattmeters from the same transmitter may vary considerably, because of variance in their termination characteristics with respect to the output of the transmitter.

7-6. INSERTION. Attach an insertion wattmeter, such as Bird Electronic Model 43 THRULINE Wattmeter, to the input connector of the Model 670 Wattmeter. Use the most direct method possible, preferably by means of the male N-type "quick-change" receptacle on the insertion section. Connect the transmitter power cable directly to the opposite connector of the THRULINE, usually female N-type. Using perhaps a 100 Watt measuring Element in the requisite frequency range, simultaneous check of the power readings is a simple matter.

7-7. SLOTTED LINE. Check wattmeter by means of usual calibrating procedures of the available slotted line power standard.

7-8. FREQUENCY CORRECTION. The power readings of the Model 670 Wattmeter show only a small variation (about ± 2%) over its stated frequency range. Figure 7-1 charts an average frequency correction factor for the typical unit.

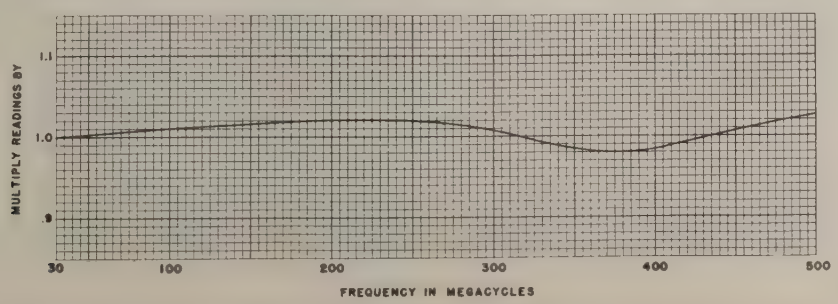


Figure 7-1. Typical Power Calibration vs. Frequency Curve (K factor)

SECTION VIII

ILLUSTRATED PARTS BREAKDOWN

8-1. INTRODUCTION

8-2. GENERAL. This Illustrated Parts Breakdown lists and describes the replaceable parts for the RF Wattmeter Model 670, manufactured by Bird Electronic Corp., Cleveland, Ohio. The Illustrated Parts Breakdown provides information on all detail parts for identification and requisitioning. This material is used in conjunction with parts described in preceding sections of this book. The breakdown consists of Sections VIII, IX, X and XI as indicated in the Table of Contents.

8-3. GROUP ASSEMBLY PARTS LIST

8-4. The Group Assembly Parts List consists of the complete RF Wattmeter Model 670 shown in figure 8-1. Each assembly is followed by its detail parts, properly indented thereunder, to show their relationship to the assembly. All parts, except common hardware, are indexed and keyed to the illustration in which they appear.

8-5. EXPLANATION OF COLUMNS.

8-6. FIGURE AND INDEX NUMBER. This column contains the figure number of each illustration followed by numerically arranged index numbers that identify detail parts included in this illustration. The figure and index number are used to assist in locating a part in the Group Assembly Parts List after it has been found in the Numerical Index.

8-7. DESCRIPTION. This column describes the parts by their manufacturer's titles or AN drawing and electrical characteristics. The descriptions are indented to show assembly relationship. Vendor part numbers are identified by the manufacturer's code letters which are placed in parentheses following the description. These code letters are taken from the Aviation Supply Office publication "Navy Code of Manufacturer's Names."

8-8. PART NUMBER. This column contains the manufacturer's numbers or AN numbers which are used to identify the parts.

8-9. UNITS PER ASSEMBLY. The quantities listed in this column of the Group Assembly Parts List are the quantities used at the location indicated. The quantities specified are not necessarily the total number used per equipment. To obtain the equipment totals, add the quantities for the item appearing in the total quantity column of the numerical index (Section X).

8-10. USABLE ON CODE. No column headed "Usable On Code" is employed in this breakdown. All parts listed are for the RF Wattmeter Model 670.

8-11. NUMERICAL INDEX.

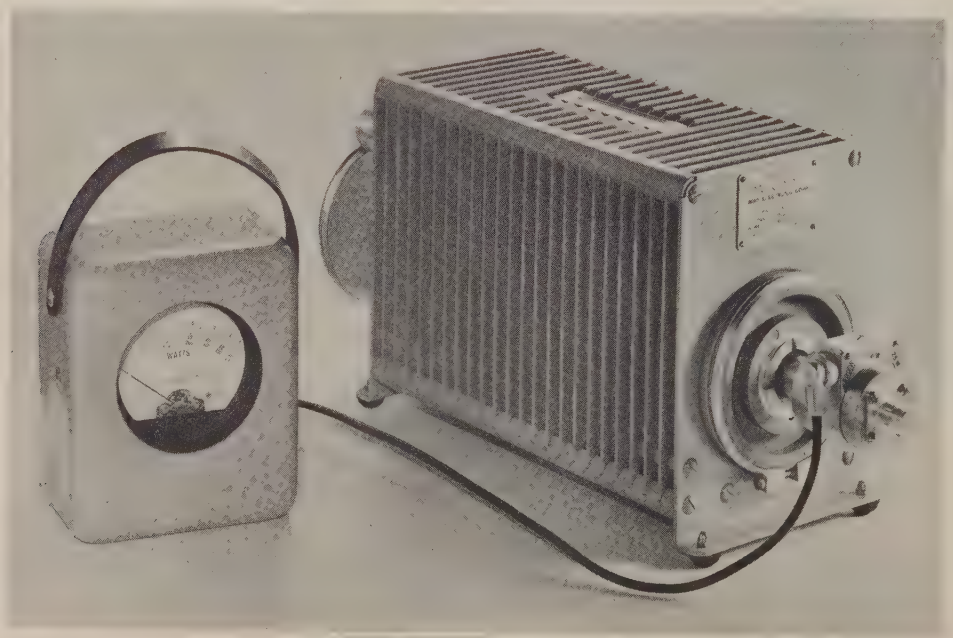


Figure 8-1. Photograph of RF Wattmeter

8-12. The Numerical Index (Section X) consists of an alpha-numerical listing of all part numbers listed in the Group Assembly Parts List (Section IX). Contractor's parts and standard and vendor's parts are combined in one listing, due to the small number of parts involved.

8-13. METHOD OF PART NUMBER LISTING.

8-14. The Numerical Index is compiled in accordance with the following system:

a. The order of precedence for the first position, beginning with the extreme left-hand character of the part number is as follows:

1. Space (blank column)
2. Diagonal (/)
3. Point (.)
4. Dash (-)
5. Letters A through Z
6. Numerals 0 through 9

8-15. NUMERICAL INDEX COLUMN HEADS.

8-16. STOCK NUMBER. This column contains Navy stock numbers assigned by the procuring agency.

8-17. PART NUMBER. This column contains all of the part numbers that appear in the Group Assembly Parts List.

8-18. SOURCE CODE. This column contains the Source Code information assigned by the procuring agency to the detail parts. An explanation of these codes is given in paragraphs 8-19 through 8-31.

8-19. CODE "P" - PARTS UNDER INVENTORY CONTROL.

8-20. (1) CODE "P" is applied to parts which are procured in view of relatively high usage. Code "P" parts may be requisitioned and installed by any maintenance level unless followed by the letter "O" which restricts requisition and replacement to Depot (O & R) level activity to manufacture supply requirements for the program.

8-21. (2) CODE "P1" is applied to parts which are difficult or uneconomical to manufacture. Code "P1" parts may be requisitioned and installed by any maintenance level unless followed by the letter "O" which restricts requisition and replacement to Depot (O & R) level activities only.

8-22. CODE "M" MANUFACTURE, PARTS NOT PROCURED.

8-23. (1) CODE "M" is applied to parts which are within the facilities of any activity to manufacture. Procurement and stocking are not justified in view of the relatively low usage. Needs are to be met by local manufacture as required.

8-24. (2) CODE "M1" is applied to parts which can be manufactured only by using the facilities of the Depot (O & R) level activities. Procurement is not justified owing to the relatively low usage and installation. The needs of all activities are to be met by Depot (O & R) level manufactured or salvage.

8-25. CODE "A" ASSEMBLY -- ASSEMBLY NOT PROCURED.

8-26. (1) CODE "A" is applied to assemblies made up of two or more units each of which carry individual part numbers and descriptions, and which may be assembled by any maintenance level.

8-27. CODE "A1" is applied to assemblies made up of two or more parts each of which carry individual part numbers and descriptions and which may be assembled only by activities having Depot (O & R) facilities.

8-28. CODE "X" PARTS CONSIDERED IMPRACTICABLE FOR MANUFACTURE OR PROCUREMENT.

8-29. (1) CODE "X" is applied to Main Structural Members or similar parts which if required would suggest extensive equipment reconditioning. The need for a part or parts so coded should normally result in the recommendation to retire the equipment from service.

8-30. (2) CODE "X1" is applied to parts for which procurement of the next higher assembly is justifiable.

8-31. (3) CODE "X2" is applied to parts which are neither procured nor stocked.

8-32. CODE* PARTS NOT PROCURED, MANUFACTURED OR STOCKED.

8-33. (1) CODE* applies to installation drawings, diagrams, instructions or basic drawing numbers which cannot be procured or manufactured.

8-34. FIGURE AND INDEX NO. This column contains the figure number and index number of the part listed in the preceding part number column. The figure number indicates the illustration in which the part appears in the Group Assembly Parts list and the index number gives the location. When no index number is designated it indicates the part is an attaching part.

8-35. TOTAL QUANTITY. The total quantity of each part is listed on the same line as the part number.

8-36. MICROFILM INDEX. This column is deleted since there is no microfilm of the equipment.

8-37. REFERENCE DESIGNATION INDEX.

8-38. This index contains the reference designations assigned to the electrical and mechanical components of the rf wattmeter. These designations are the same as those used on the illustrated diagram in figure 6-3 used for parts reference in maintenance activities. The designations assigned to internal components on the schematic diagrams figure 1-3 & figure 6-4 are for functional description only, as they are not subject to parts replacement, and do not appear in the Group Assembly Parts List. The reference designa-

tion is made up of a block capital letter and a number. The letter identified the particular type of component; ie, "H" for hardware, "O" mechanical parts, while the number identifies the particular part (screw or clamp, etc). In the rf wattmeter all designations begin with number 301 and run up to 308 in one category. Reference designations in this index are listed in alphabetical order by type and in numerical order under each type. This index is used to locate a part in the equipment from its designation or to determine the manufacturer and description of a part when its designation is known.

8-39. MANUFACTURER'S NAME CODE SYMBOL.

8-40. Nearly all the items in the Group Assembly Parts List are designed and/or manufactured by the prime contractor, Bird Electronic Corp. A few of the parts are supplied as vendor items, and these are identified by code letters in parenthesis following the description in the Parts List.

The manufacturer's codes used are as follows:

ATI	ATLANTIC INDIA RUBBER WORKS INC. Chicago, Illinois
BDN	BELDEN MANUFACTURING CO. Chicago, Illinois
HIE	HICKOK ELECTRICAL INSTRUMENT CO. Cleveland, Ohio
SLE	SYLVANIA ELECTRIC PRODUCTS CO. Cincinnati, Ohio

8-41. HOW TO USE THIS ILLUSTRATED PARTS BREAKDOWN.

8-42. To permit complete identification of components, assemblies, and detail parts by part number or illustration, the procedure outlined in table below is recommended.

How to Use Illustrated Parts Breakdown

You Have	To Find	The Procedure
Part Number	Stock Number Source Code, or Figure Index	a. Refer to section X. b. Locate part number. c. Stock number, source code, and figure index number are listed opposite part number.
Part Number	Illustration, Description, Next higher assy, Units per assy, or Manufacturer	a. Refer to section X. b. Locate part number. c. Figure index is listed opposite number. d. Refer to section IX using figure index. e. Description, next higher assembly, manufacturer, and units per assy are listed opposite part number.
Location of Part	Part Number Stock Number Source Code Figure Index Quantity per article	a. Refer to section IX, to locate illustration. b. Locate figure index of part in illustration. c. Refer to figure index in Group Assembly Parts List. d. Part Number is listed opposite figure index. e. Refer to section X using part number. f. Locate part number. g. Stock number, Source Code, Figure Index and Quantity per Article are listed after part number.

SECTION IX
GROUP ASSEMBLY PARTS LIST

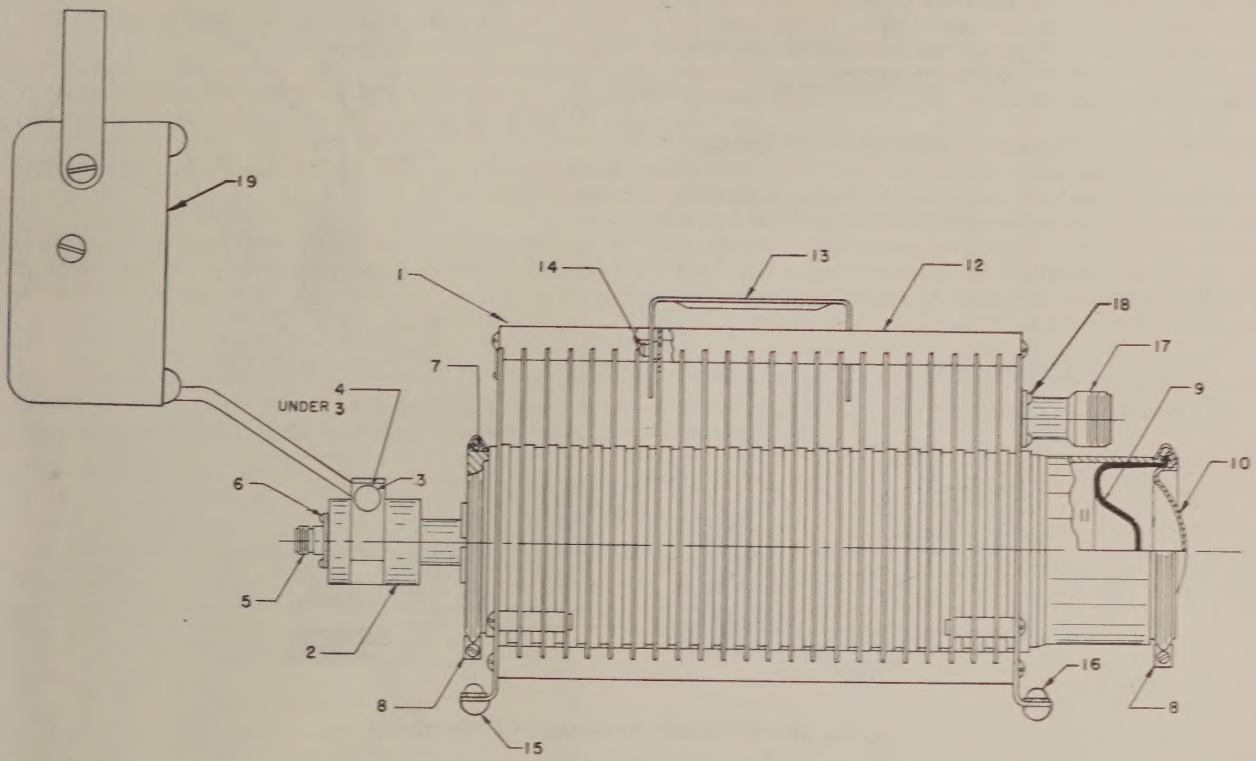


Figure 9-1. RF Wattmeter Assembly

Figure and Index No.	Part Number	Description 1 2 3 4 5 6 7	Units per Assy
9-1	670001	RF WATTMETER ASSEMBLY (MODEL 670)	1
-1	670002	. LOAD RESISTOR ASSEMBLY, 500 Watt, 50 Ohm	1
-2	670004	. . RESISTOR-VOLTMETER UNIT	1
-3	673046	. . . CAP, Crystal Diode	1
-4	750180	. . . CRYSTAL DIODE, Operating 1N79 (SLE) See Note A	1
-5	424062	. . . CONNECTOR RF (N-type)	1
-6	AN-515-8-5	. . . SCREW, Machine	4
-7	81139	. . . O-RING, Seal, AN6230B-20	1
-8	24343	. . V-BAND, Clamping	2
-9	24315	. . DIAPHRAGM, Expansion	1
-10	24335-2	. . COVER, Diaphragm	1
-11	5030	. . OIL, Dielectric (OT) one gallon	
-12	24352	. . RADIATOR	1
-13	24328	. . . HANDLE	1
-14	24340	. . . SCREW, Shoulder	1
-15	5049	. . . BUMPER, Foot #255 (ATI)	4
-16	811171	. . . NUT, Acorn	4
-17	424031	. . CONNECTOR, RF (LC-type) Alternate	1
-18	AN-515-8-5	. . SCREW, Machine	2
-19	82492-12	. METER ASSEMBLY (see figure 9-2)	1

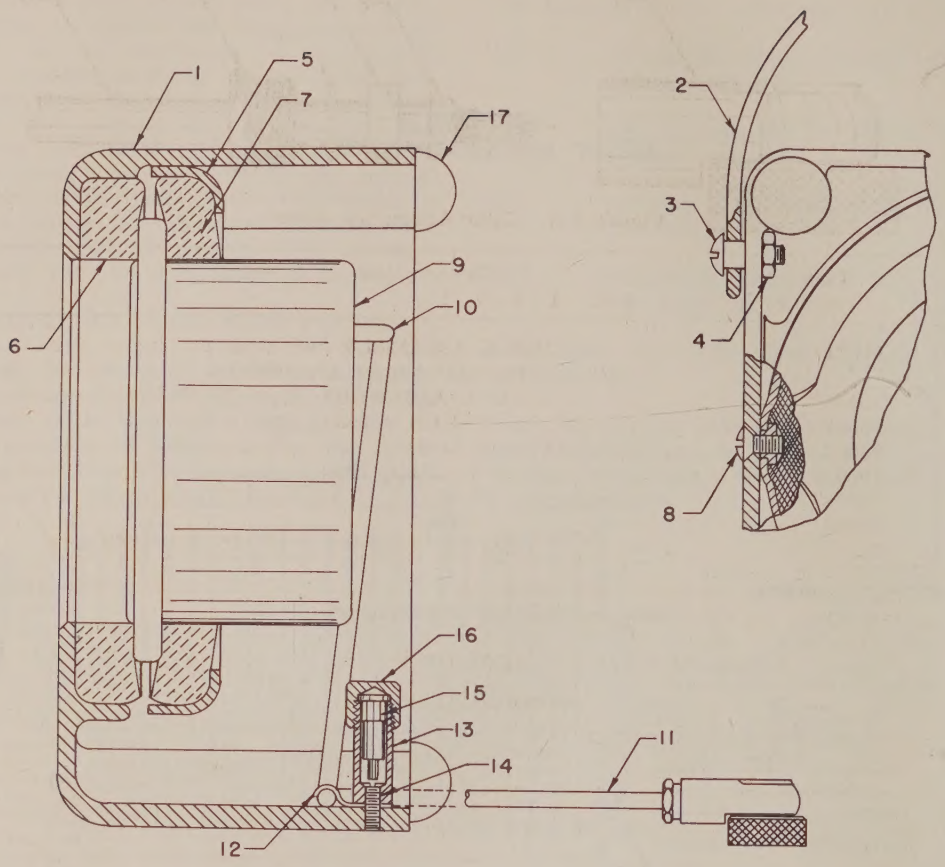


Figure 9-2. Meter Assembly, RF Wattmeter

Figure and Index No.	Part Number	Description 1 2 3 4 5 6 7	Units per Assy
9-2	82492-12	. METER ASSEMBLY (See Item 19, figure 9-1 for next higher assembly)	Ref
-1	82488	. . HOUSING	1
-2	824104	. . STRAP, Carry	1
-3	5174	. . SCREW, Strap	2
-4	AN-315-3	. . NUT Locking	2
-5	82493	. . RING, Meter Mount	1
-6	81866	. . SHOCK STRIP, Front	1
-7	81867	. . SHOCK STRIP, Rear	1
-8	5173	. . SCREW, Meter Mount	2
	81895-2	. . METER SUB-ASSEMBLY.	1
-9	81843-4	. . . METER, Model 48HS, 100 ua, ± 2% f. s. (HIE).	1
-10	5127-4	. . . TUBING	1
-11	81821-1	. . . CABLE ASSEMBLY (See figure 9-3).	1
-12	2249	. . CABLE CLAMP.	1
-13	673041	. . HOLDER, Spare Crystal.	1
-14	673048	. . SCREW, Crystal holder	1
-15	750180	. . CRYSTAL, Spare 1N79 (SLE) See Note A.	1
-16	673042	. . CAP, Spare crystal	1
-17	5049	. . BUMPER, Foot #255 (ATI)	4

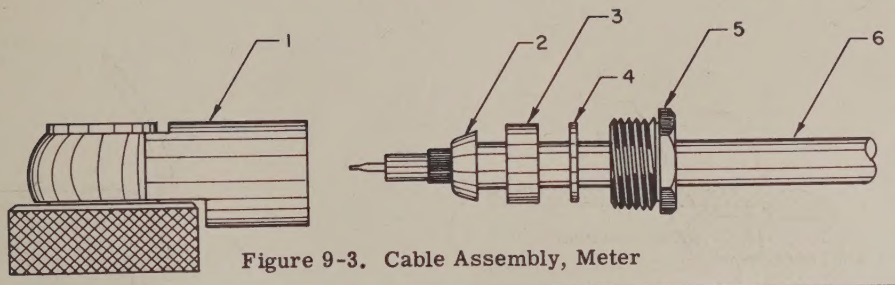


Figure 9-3. Cable Assembly, Meter

Figure & Index No.	Part Number	Description 1 2 3 4 5 6 7	Units per Assy
9-3	81821-1	. . . CABLE ASSEMBLY (See item 11, figure 9-2 for next higher assembly)	Ref
	75076	. . . . PLUG ASSEMBLY Type DS-491859	1
-1	75088	. . . . . SHELL, Captive Nut.	1
-2	75080	. . . . . WEDGE	1
-3	75081	. . . . . WASHER, Seal	1
-4	75074	. . . . . WASHER, Compression	1
-5	75082	. . . . . SCREW	1
-6	RG-58/U	. . . . CABLE, Shielded - 10'-2" lg. #8240 (BDN) .	1

NOTE A: This part cannot be furnished separately; both 9-1-4 and 9-2-15 are furnished only with 9-1-2 (Resistor-Voltmeter Unit) for which they are selected and assigned.

SECTION X

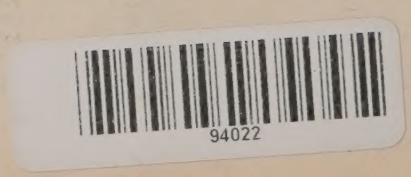
NUMERICAL INDEX

CLASS CODE OR STOCK NO.	PART NUMBER	SOURCE CODE	FIGURE AND INDEX NO.	QTY PER ARTICLE
	AN315-3		9-2-4	2
	AN515-8-5		9-1-6 & 18	6
	RG-58/U		9-3-6	1
	2249		9-2-12	1
	24315		9-1-9	1
	24328		9-1-13	1
	24335-2		9-1-10	1
	24340		9-1-14	1
	24343		9-1-8	2
	24352		9-1-12	1
	424031		9-1-17	1
	424062		9-1-5	1
	5030		9-1-11	
N17-B-775001-216	5049		9-1-15 & 9-2-17	8
	5127-4		9-2-10	1
	5173		9-2-8	2
	5174		9-2-3	2
	670001		9-1	1
	670002		9-1-1	1
	670004		9-1-2	1
	673041		9-2-13	1
	673042		9-2-16	1
	673046		9-1-3	1
	673048		9-2-14	1
	750180		9-1-4 & 9-2-15	2
	75074		9-3-4	1
N17-C-70811-7901	75076		9-3	1
	75080		9-3-2	1
	75081		9-3-3	1
	75082		9-3-5	1
	75088		9-3-1	1
	811171		9-1-16	4
	81139		9-1-7	1
	81821-1		9-2-11	1
	81843-4		9-2-9	1
	81866		9-2-6	1
	81867		9-2-7	1
	81895-2		9-2	1
	824104		9-2-2	1
	82488		9-2-1	1
	82492-12		9-1-19	1
	82493		9-2-5	1

SECTION XI

REFERENCE DESIGNATION INDEX

REFERENCE DESIGNATION	FIGURE INDEX	CLASS CODE OR STOCK NUMBER	PART NUMBER
A302	9-2-1		82488
A303	9-1-12		24352
A304	9-1-10		24335-2
A301	9-2-5		82493
CR301	9-1-4		750180
CR302	9-2-15		750180
E301	9-1-2		670004
H301	9-1-3		673046
H302	9-1-15	N17-B-775001-216	5049
H302	9-2-17	N17-B-775001-216	5049
H303	9-2-16		673042
H304	9-2-3		5174
H305	9-1-14		24340
H306	9-1-16		811171
J301	9-1-17		424031
J302	9-1-5		424062
M301	9-2-9		81843-4
0301	9-1-8		24343
0302	9-1-8		24343
0303	9-1-7		81139
0304	9-1-9		24315
0305	9-1-13		24328
0306	9-2-2		824104
0307	9-2-6		81866
0308	9-2-7		81867
P301	9-3	N17-C-70811-7901	75076
W301	9-2-11		81821-1
W301.1	9-3-6		RG-58/U
X301	9-2-13		673041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